IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : George Cintra et al. Art Unit : 1745
Serial No. : 10/034,901 Examiner : Raymond Alejandro
Filed : December 27, 2001
Title : BATTERY ELECTRODE AND METHOD OF MAKING THE SAME

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Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

BRIEF ON APPEAL

Appellants are appealing the final rejections of claims 52-61 in the final Office Action mailed on September 19, 2005. Appellants request that the rejections be reversed. A Notice of Appeal was filed on December 16, 2005.

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Typed or Printed Name of Person Signing Certificate

(1) Real Party in Interest

The real party in interest is The Gillette Company, Prudential Tower Building, Boston, Massachusetts 02199-8004. The Gillette Company has been acquired by the Procter & Gamble Company.

(2) Related Appeals and Interferences

There are no known related appeals or interferences.

(3) Status of Claims

Claims 1, 3-15, and 45-62 are pending. However, Appellants have filed an amendment canceling claims 1, 3-15, 45-51, and 62 to simplify the issues for appeal.

Claims 52-61 are rejected under 35 U.S.C. § 103(a) as obvious over Johnson et al., U.S. Pat. 6,402,796 ("Johnson") in view of Fukumura et al., U.S. Pat. 5,834,052 ("Fukumura") and/or Fukumura in view of Johnson, in each case further in view of Hamamoto et al., U.S. Application Publication 2002/0168576 ("Hamamoto"). Claims 52-61 are also rejected under 35 U.S.C. § 103(a) as obvious over Johnson in view of Hamamoto.

(4) Status of Amendments

Appellants have filed an Amendment along with this brief canceling claims 1, 3-15, 46-51, and 62 to simplify the issues for appeal. Appellants assume that this amendment will be entered. All other amendments have been entered.

(5) Summary of Claimed Subject Matter

A battery is an electrical energy source including an anode and a cathode. The anode includes an anode active material that can be oxidized; the cathode includes a cathode active material that can be reduced. In the battery, electrical contact is made between the anode and the cathode, allowing a current to flow through the battery as a result of the oxidation and reduction occurring at the anode and cathode, respectively. The anode and the cathode each include a current collector that helps provide electrical contact between the anode and the cathode. See generally Application at ¶¶ 0002-0004 (Background).

The claimed subject matter relates to methods of making cathodes. Prior methods of making cathodes included coating a cathode mixture directly on a current collector. The cathode mixture included the cathode active material, a binder, and a solvent. The solvent functioned as a carrier for the other components of the cathode mixture, and the binder helped bind the cathode active material together in the final cathode. After coating, the cathode mixture was dried to remove the solvent. This could result in problems, as discussed in the Background section of the application:

> In some cases, the cathode is formed by coating a cathode mixture directly on a current collector, e.g., a conductive mesh. After coating, the cathode mixture is dried [to remove the solvent]. Drying can cause the cathode to shrink, and in some cases, cause excessive stress in the cathode that lead to undesirable defects, such as cracks, and/or loss of adhesion to the current collector. As a result, this method of making a cathode can limit the loading (the amount of active material that can be formed on the cathode) and the performance of the cathode and the battery in which the cathode is used.

Application at ¶ 0004.

Applicants have discovered methods that address these problems. The example in the Detailed Description is an embodiment of the methods. In the example, a cathode mixture including an cathode active material, a binder, and a solvent is coated onto a removable substrate. Application at ¶¶ 0059-0060. Then, the cathode mixture is at least partially dried to remove solvent, and the substrate is removed to provide a cathode layer. Application at ¶¶ 0060-0061. Multiple cathode layers are combined to form a cathode; a current collector then is attached to the cathode. Application at ¶¶ 0062-0064. Using this approach, a cathode can be made having a relatively high loading of cathode active material that is relatively thick with

minimal defects such as cracks. As a result, the performance of the cathode can be enhanced. Application at ¶ 0006.

This appeal will center on claims 52, 55, and 60. Each of these claims relates to methods of making a cathode by forming a first layer including a cathode mixture onto a substrate, removing the substrate from the first layer, and incorporating the first layer into a cathode. Claims 52 and 60 are independent and differ from each other concerning the materials required for the cathode mixture. Claim 52 requires that the cathode mixture include an electrode (cathode) active material and a binder:

> 52. A method of making a battery electrode, the method comprising:
>
> forming a first layer comprising a cathode mixture on a substrate;
>
> removing the substrate from the first layer; and
>
> incorporating the first layer into the battery electrode,
>
> wherein the cathode mixture comprises an electrode active material and a binder.

Claim 55 depends from claim 52 and requires that the cathode mixture also include a solvent.

Claim 60 requires that the cathode mixture include an electrode active material and a solvent:

> 60. A method of making a battery electrode, the method comprising:
>
> forming a first layer comprising a cathode mixture on a substrate, the cathode mixture comprising an electrode active material and a solvent;
>
> removing the substrate from the first layer; and
>
> incorporating the first layer into the battery electrode.

(6) Grounds of Rejection

Appellants are appealing all of the 35 U.S.C. § 103(a) rejections of claims 52-61. For purposes of this appeal, claims 52-54, 58, and 59 (cathode mixture includes a cathode active material and a binder) stand or fall together; claims 55-57 (cathode mixture also includes a solvent) stand or fall together; and claims 60 and 61 (cathode mixture includes a cathode active material and a solvent) stand or fall together.

(7) Argument

First, Appellants will explain why the 35 U.S.C. § 103(a) rejection based on Johnson in view of Hamamoto should be reversed. Appellants then will explain why the 35 U.S.C. § 103(a) rejection based on Johnson in view of Fukumura and further in view of Hamamoto should be reversed. Finally, Appellants will explain why the 35 U.S.C. § 103(a) rejection based on Fukumura in view of Johnson and further in view of Hamamoto should be reversed.

(A) The 35 U.S.C. § 103(a) Rejection Based on Johnson in View of Hamamoto Should Be Reversed

Appellants will discuss Johnson and then Hamamoto.

(i) Johnson

Johnson describes depositing a cathode active material (a lithium compound) on a substrate by sputtering, and later removing the substrate by sputtering. Sputtering involves bombarding a source material (the cathode active material) with positive ions of an inert gas. Particles of the cathode active material are vaporized during the bombardment and ultimately deposit and solidify on the substrate.

The actual process described by Johnson is rather complex and involves using a series of sputtering and annealing stations to produce the lithium battery shown below:

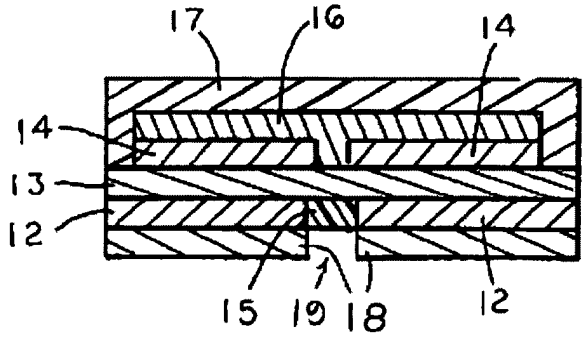


FIG. 1

The lithium battery includes cathodes 12, which consist of the lithium compound, insulator 15 between cathodes 12, cathode current collectors 18, electrolyte 13, anodes 14, anode current collector 16, and protective layer 17. See col. 2, lines 5-28.

Sputtering chamber 20 is the first chamber used in producing the lithium battery:

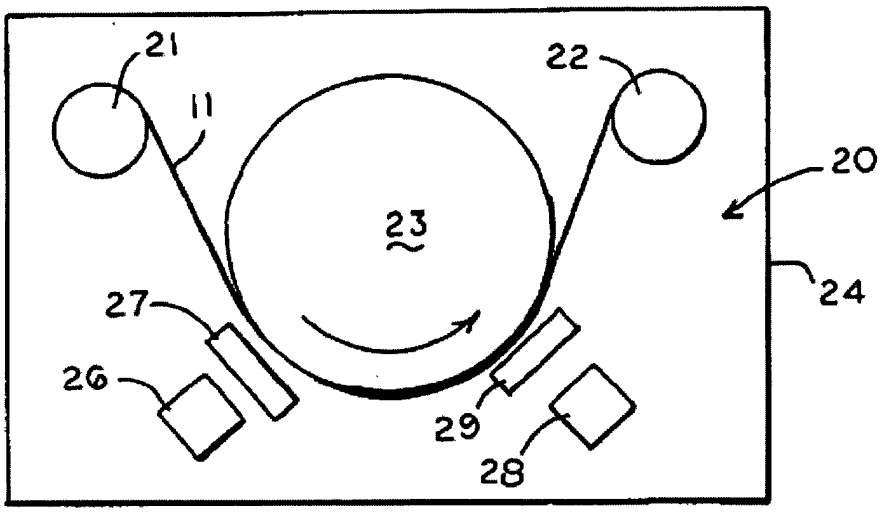


FIG. 6

In sputtering chamber 20, insulator 15 initially is deposited along web substrate 11 by sputtering as web substrate 11 passes insulator sputtering device 26. See col. 3, lines 24-35. Then, cathodes 12 are deposited along web substrate 11 on both sides of insulator 15 as web substrate 11 passes cathode sputtering device 28. See col. 3, lines 35-45. Cathode sputtering device 28 uses a sputtering target composed of the cathode active material. See col. 3, lines 38-40.

Web substrate 11 is the substrate that ultimately is removed by sputtering. Before that happens, the web passes through an annealing station (30 in Fig. 7) to anneal the cathode active material (see col. 7, lines 46-61); a second sputtering chamber (40 in Fig. 8) in which electrolyte 13 is deposited by sputtering (see col. 3, line 62 - col. 4, line 6); and a third sputtering chamber (50 in Fig. 9) in which anodes 14 and anode current collector 16 are deposited by sputtering (see col. 3, lines 7-35).

After leaving third sputtering chamber 50, the layers in the web generally appear as shown below:

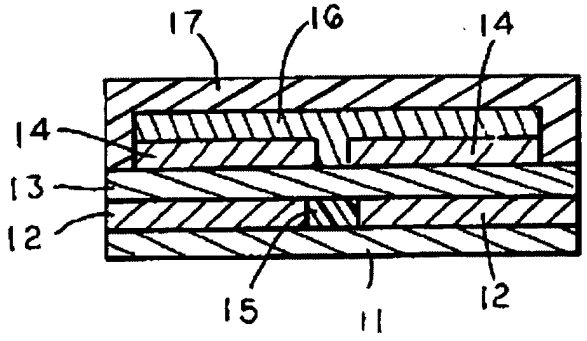


FIG. 1A

Note that the web in Fig. 1A includes web substrate 11 and not the cathode current collectors 18 that are present in the finished lithium battery shown in Fig. 1.

The web subsequently is moved into fourth sputtering chamber 60:

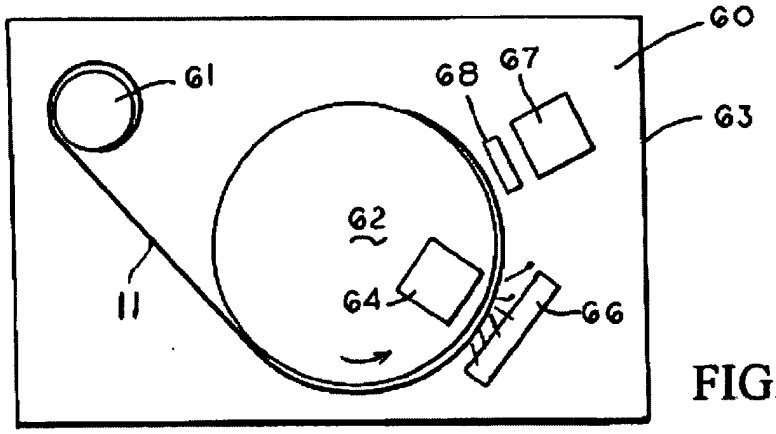


FIG. 10

In sputtering chamber 60, the web initially passes between sputtering electrode 64 and plate 66. See col. 4, lines 40-53. Sputtering electrode 64 is activated and causes a reverse sputtering in which web substrate 11 is removed from the web and deposited on plate 66. See col. 4, lines 40-53. The web (lacking web substrate 11) passes cathode current collector sputtering device 67 and cathode current collectors 18 are deposited by sputtering on cathodes 12. See col. 4, lines 54-62.

Johnson discloses that other analogous chemical vapor deposition or physical vapor deposition processes also can be used in place of sputtering. See col. 5, lines 15-25. Chemical vapor deposition and physical vapor deposition, like sputtering, involve initially vaporizing the target material and subsequently depositing the material on the substrate.

The cathode active material deposited by Johnson by sputtering includes only the cathode active material (the lithium compound). The lithium compound is not combined with a binder or a solvent. The lithium compound is vaporized during sputtering and deposited directly on the substrate. Thus, there is no reason to use a solvent as a carrier for the cathode active material because sputtering processes do not employ solvents; using a solvent would make no sense technically. Similarly, the cathode active material deposited by Johnson by sputtering solidifies on web substrate 20 and then is annealed to further harden the material. There is no reason to use a binder, and using a binder would make no sense technically.

Moreover, Johnson's sputtering technique is not designed for use with a cathode mixture including a solvent and a binder in addition to the lithium compound. The sputtering targets used, for example, in cathode sputtering device 28 is composed of the solid cathode active material (the lithium compound) that during sputtering is bombarded with ions and vaporized. A person of ordinary skill in the art would have to figure out how to sputter target(s) including a solvent and/or a binder in addition to the cathode active material in order to deposit a cathode mixture on the substrate. Not surprisingly, Johnson does not provide any guidance indicating that such an approach would even be technically feasible.

(ii) Hamamoto

Hamamoto largely concerns a particular non-aqueous electrolyte for use in a lithium battery. The lithium battery includes a cathode, and Hamamoto does describe a method for making the cathode. The method includes coating a cathode mixture in the form of a paste onto a support that ultimately functions as the cathode current collector. See ¶ 0043. The cathode mixture includes a cathode active material, a carbon conductive agent, a binder, and a solvent. See ¶¶ 0042-0043. After coating, the cathode mixture is dried to remove the solvent. See ¶ 0043. Significantly, the current collector is not removed from the cathode mixture after drying. This makes sense, since the current collector is a functional component of the cathode. The current collector is incorporated into the lithium battery along with the rest of the cathode.

As a practical matter, Hamamoto is an example of the prior art methods for making cathodes discussed in the Background section of the present application.

(iii) The Rejection Should Be Reversed

The Examiner rejected claims 52-61 under 35 U.S.C. § 103(a) based on the combination of Johnson and Hamamoto. Appellants will explain why this rejection should be reversed after first discussing the applicable law.

35 U.S.C. § 103(a) provides in relevant part:

> (a) A patent may not be obtained... if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

In order to find a claim obvious under 35 U.S.C. § 103(a), there must be a suggestion in the prior art to combine or modify the prior art to obtain the subject matter covered by the claim. See, for example, in In re Oetiker, 977 F.2d 1443, 1447 (1992), where the Federal Circuit explained:

> There must be some reason, suggestion, or motivation found in the prior art whereby a person of ordinary skill in the field of the invention would make the combination.

The Federal Circuit has cautioned repeatedly that the suggestion or motivation required for obviousness cannot derive from a hindsight reconstruction of the claimed invention that uses the claim as a roadmap for establishing obviousness. For example, in In re Fritch, 972 F.2d 1260, 1266 (1992), the Federal Circuit noted:

> [I]t is impermissible to use the claimed invention as an instruction manual or 'template' to piece together the teachings of the prior art so that the claimed invention is rendered obvious....

Similarly, in W.L. Gore and Associates v. Garlock, Inc., 721 F.2d 1540, 1553 (Fed. Cir. 1983) the Federal Circuit observed:

> To imbue one of ordinary skill in the art with knowledge of the invention when no prior art reference or references of record convey or suggest that knowledge, is to fall victim to the insidious effect of a hindsight syndrome wherein that which only the inventor taught is used against its teacher.

The Examiner contends that a person of ordinary skill in the art would have been motivated to use Hamamoto's cathode mixture in Johnson's sputtering process. See page 14 of the office action dated September 19, 2005. It is difficult to imagine a more hindsight-based

rationale for a 35 U.S.C. § 103(a) rejection. Hamamoto's cathode mixture is designed for a coating process and includes specific components -- the solvent and the binder in particular -- that aid the coating process. The solvent is a carrier that allows the cathode active material to be coated, and the binder helps bind the active cathode material together when the solvent subsequently is removed. Johnson's sputtering technique does not require a solvent or a binder because the cathode active material is vaporized during sputtering and redeposited as a solid directly on the substrate. Solvents and binders are unnecessary.

Appellants acknowledge that Johnson and Hamamoto teach using lithium compounds as a cathode active material in lithium batteries. But at most all this means is that a person of ordinary skill in the art might look to Hamamoto for lithium compounds that potentially could be used in Johnson's sputtering procedure. But that would still leave a method that lacked a cathode mixture containing the solvent required by claims 60 and 61, the binder required by claims 52-54, 58, and 59, and the combination of a solvent and a binder required by claims 55-57.

For the above reasons, Appellants request that the 35 U.S.C. § 103(a) rejection based on the combination of Johnson with Hamamoto be reversed.

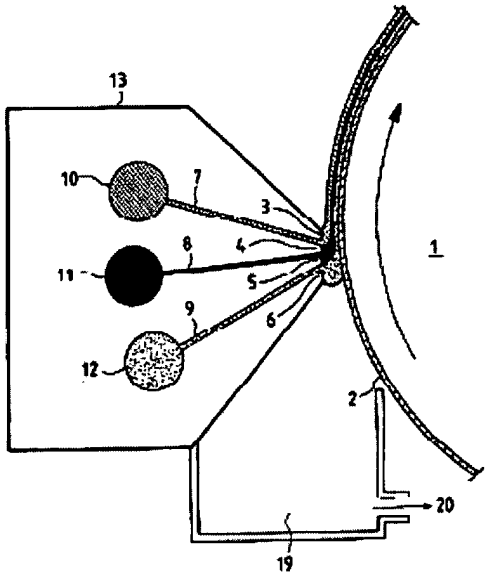
(B) The 35 U.S.C. § 103(a) Rejection Based on Johnson in View of Fukumura and Further in View of Hamamoto Should Be Reversed

Appellants will initially discuss Fukumura; Johnson and Hamamoto were discussed above.

(i) Fukumura

Fukumura describes a method of making a cathode sheet for a lithium battery using a special coating procedure. The coating procedure is illustrated below:

FIG. 1



In Fukumura's method, a series of liquid coating mixtures 10, 11, and 12 are coated simultaneously onto a base material sheet 2. See col. 3, lines 5-44. In the embodiment described by Fukumura, the middle coating (resulting from coating mixture 11) includes the cathode mixture including the cathode active material. Fukumura describes one specific example of a cathode mixture for use as coating mixture 11, and that mixture includes the cathode active material (a lithium salt), a binder, a solver (water), a conductive agent, and carboxymethyl cellulose. See col. 6, lines 33-41. In the embodiment described by Fukumura, coating mixture 12 is an adhesive that binds the cathode mixture (coating mixture 11) to base material sheet 2, and coating mixture 9 is an outer protective layer. See col. 5, line 66 - col. 6, line 16. After the coating step, the coating mixtures subsequently are dried to remove the solvents, including the water from the cathode mixture. See col. 9, lines 41-45.

The key feature of Fukumura's method is that all of the coating steps are done simultaneously. This improves efficiency and apparently reduces coating defects common to other coating procedures. As Fukumura explains (col. 10, lines 54-64):

> In the case of using the method of this invention for producing an electrode sheet, even when the necessity of making the electrode having a multilayer structure for improving the fundamental characteristics of a battery, such as, for example, a safety, it becomes possible to simultaneously coat the plural layers, and thus even when the number of the layers necessary for constituting an electrode is increased, they can be efficiently coated without greatly prolonging the finishing time for the electrode. Furthermore, the occurrence of coating defects can be restrained and the battery performance is improved.

Base material sheet 2 ultimately functions as the cathode current collector in cathodes made using Fukumura's method. See col. 3, lines 55-60. Thus, using an adhesive as coating mixture 12 serves the function of adhering the cathode active material (derived from coating mixture 11) to the cathode current collector (base sheet material 2).

(ii) The Rejection Should be Reversed

The Examiner contends that a person of ordinary skill in the art would have been motivated to use Fukumura's cathode mixture in Johnson's sputtering process. See pages 6 and 9 of the Office Action dated September 19, 2005. This is nonsense, for the same general reasons (discussed above) that the combination of Hamamoto with Johnson is nonsense. Fukumura's cathode mixture is designed for a coating process and includes specific components -- the solvent and the binder in particular -- that aid in the coating process. The solvent is a carrier that allows the active cathode material to be coated, and the binder help hold the active cathode when the solvent subsequently is removed. Johnson's sputtering technique does not require a solvent or a binder because the cathode active material is vaporized during sputtering and redeposited as a solid directly on the substrate. Solvents and binders unnecessary.

Appellants acknowledge that Johnson and Fukumura teach using lithium compounds as a cathode active material in lithium batteries. But at most all this means is that a person of ordinary skill in the art might look to Fukumura for lithium compounds that potentially could be used in Johnson's sputtering procedure. But that would still leave a method that lacked a cathode mixture containing the solvent required by claims 60 and 61, the binder required by claims 52-54, 58, and 59, and the combination of a solvent and binder required by claims 55-57.

Hamamoto adds nothing of significance to Fukumura, for the reasons previously discussed. Fukumura and Hamamoto describe analogous cathode mixtures (including a solvent

and a binder) that are used to coat a substrate that is a functioning component (the current collector) of the cathode.

For the above reasons, the 35 U.S.C. § 103(a) rejection based on Johnson in view of Fukumura and further in view of Hamamoto should be reversed.

(C) The 35 U.S.C. § 103(a) Rejection Based on Fukumura in View of Johnson and Further in View of Hamamoto Should Be Reversed

This rejection derives from flipping the order of the primary reference (Johnson) and the first secondary reference (Fukumura) from the rejection just discussed. The technical rationale for the rejection of claims 52-61 based on Fukumura in view of Johnson and further in view of Hamamoto is a bit cloudy. See pages 9 and 10 of the Office Action mailed September 19, 2005. But the Examiner appears to contend that a person of ordinary skill in the art would have been motivated to substitute web substrate 11 from Johnson's sputtering procedure for base material sheet 2 in Fukumura's coating process.

However, this substitution does not make sense technically. Base material sheet 2 is the current collector for the final cathode and is not designed to be removed. In fact, as discussed above, Fukumura uses an adhesive (coating mixture 12) to tightly bond the cathode (derived from coating mixture 11) to the current collector (base material sheet 2). Fukumura does not want to use a removable base material sheet; if he did, he would subsequently have to incorporate a current collector into the cathode, which would run counter to one of Fukumura's primary goals (efficiency).

Moreover, web substrate 11 in Johnson's process is removed in a sputtering chamber (60 in Fig. 10). In fact, Johnson's process involves a series of sputtering chambers that are far removed technically from the simultaneous coating process described by Fukumura.

Furthermore, the cathode arrangements produced by Johnson and Fukumura are substantially different. Fukumura produces a cathode sheet in which the coated layers extend across the entire substrate (base material 2). Johnson, in contrast, forms a series of separate cathodes (12) that are separated by insulators (15), and then forms the remainder of the battery as successive layers on top of the cathodes.

A person of ordinary skill in the art, practicing Fukumura's simultaneous coating process, would not look to Johnson's technically remote process for guidance, let alone attempt to incorporate Johnson's sputterable web substrate 11 into Fukumura's simultaneous coating process.

Hamamoto does not add anything of significance to the process. In fact, Hamamoto, like Fukumura, coats a cathode mixture onto a substrate that ultimately functions as the current collector for the cathode.

For the above reasons, Appellants request that the 35 U.S.C. § 103(a) rejection based on the combination of Fukumura in view of Johnson and further in view of Hamamoto be reversed.

(8) Conclusion

Appellants respectfully request that the 35 U.S.C. § 103(a) rejection of claims 52-61 be reversed.

The brief fee of $500 is enclosed. Please apply any other charges or credits to Deposit Account No. 06 1050.

Respectfully submitted,

Date: March 16, 2006

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Appendix of Claims

1. A method of making a battery electrode, the method comprising:
forming a first layer comprising a cathode mixture on a substrate;
removing the substrate from the first layer; and
incorporating the first layer into the battery electrode,
wherein the cathode mixture is in the form of a slurry.

3. The method of claim 1, wherein the substrate comprises a material selected from a group consisting of a polymer, a metal, and paper.

4. The method of claim 1, wherein the substrate comprises a polymer.

9. The method of claim 1, further comprising contacting the separated first layer with a current collector.

10. The method of claim 9, further comprising bonding the separated first layer and the current collector under pressure.

11. The method of claim 9, wherein the current collector includes an electrically conductive binder.

14. The method of claim 1, wherein forming the first layer or removing the substrate is performed in a continuous process.

15. The method of claim 1, wherein forming the first layer and removing the substrate are performed in a continuous process.

46. The method of claim 1, wherein the cathode mixture comprises a solvent.

47. The method of claim 46, further comprising removing a portion of the solvent from the cathode mixture after forming the first layer comprising the cathode mixture on the substrate.

48. The method of claim 47, wherein the portion of solvent that is removed is no greater than 1200 ppm.

49. The method of claim 47, wherein at least some of the portion of solvent is removed prior to removing the substrate from the first layer.

50. The method of claim 1, wherein the cathode mixture comprises a conductive aid.

51. The method of claim 1, wherein the cathode mixture comprises a binder.

52. A method of making a battery electrode, the method comprising:
forming a first layer comprising a cathode mixture on a substrate;
removing the substrate from the first layer; and
incorporating the first layer into the battery electrode,
wherein the cathode mixture comprises an electrode active material and a binder.

53. The method of claim 52, wherein the binder comprises a polymer.

54. The method of claim 53, wherein the binder is selected from the group consisting of polyvinylidene fluoride, hexafluoropropylene, and polytetrafluoroethylene.

55. The method of claim 52, wherein the cathode mixture further comprises a solvent.

56. The method of claim 55, wherein the solvent is selected from the group consisting of acetone, methyl ethyl ketone, diisobutyl ketone, methylpyrrolidone, and methyl isobutyl ketone.

57. The method of claim 56, further comprising removing a portion of the solvent after forming the first layer on the substrate.

58. The method of claim 52, wherein the cathode mixture further comprises a conductive aid.

59. The method of claim 58, wherein the conductive aid comprises carbon.

60. A method of making a battery electrode, the method comprising:
forming a first layer comprising a cathode mixture on a substrate, the cathode mixture comprising an electrode active material and a solvent;
removing the substrate from the first layer; and
incorporating the first layer into the battery electrode.

61. The method of claim 60, wherein the solvent is selected from the group consisting of acetone, methyl ethyl ketone, diisobutyl ketone, methylpyrrolidone, and methyl isobutyl ketone.

62. A method of making a battery electrode, the method comprising:
forming a first layer comprising a cathode slurry mixture on a substrate;
removing the substrate from the first layer; and
incorporating the first layer into the battery electrode,
wherein the cathode mixture comprises an electrode active material, a conductive aid, a binder, and a solvent.

Evidence Appendix

None.

Related Proceedings Appendix

None.